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Converting $H\alpha$ Luminosities into Star Formation Rates

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Abstract. The recent finding that the IGIMF (integrated galaxial initial stellar mass function) composed of all newly formed stars in all young star clusters has, in dependence of the SFR, a steeper slope in the high mass regime than the underlying canonical IMF of each star cluster offers new insights into the galactic star formation process: The classical linear relation between the SFR and the produced $H\alpha$ luminosity is broken and SFRs are always underestimated. Our new relation is likely to lead to a revision of the cosmological SFH.

1. SFR- $H\alpha$ -relation

To obtain a relation between the total galactic wide SFR and the produced $H\alpha$ luminosity the IGIMF as a function of the SFR is combined with stellar evolution models. The resulting relations for four different IGIMF scenarios, introduced by Weidner & Kroupa (2005), are plotted in Fig. 1 (right). For a given $H\alpha$ luminosity the SFRs are always higher than in the classical linear relations by Kennicutt Jr., Tamblyn & Congdon (1994) (grey shaded area, solid line). In addition, two classical models are included where the IGIMF is identical to a Salpeter IMF and a canonical IMF but using the same stellar evolution models as used in the IGIMF models.

2. dIrr galaxies

Applying our SFR- $L_{H\alpha}$ relation to the observed $H\alpha$ -luminosities of the Sculptor dwarf irregular galaxies (Skillman et al. 2003) the SFRs (Fig. 2, left) and related parameters such as the gas depletion time scale (Fig. 2, right) change dramatically.

References

- Kennicutt Jr. R. C., Tamblyn P., Congdon C. E., 1994, ApJ, 435, 22
Skillman E. D., Côté S., Miller B. W., 2003, AJ, 125, 593
Weidner C., Kroupa P., 2005, ApJ, 625, 754

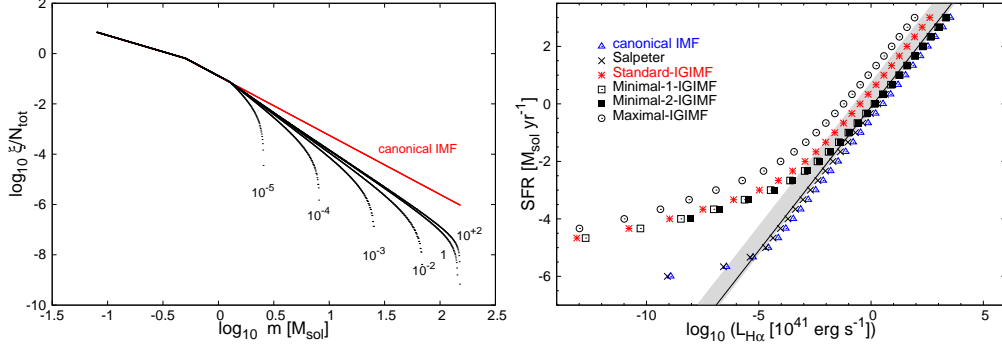


Figure 1. *Left:* The IGIMF in dependence of the total SFR in the standard scenario. *Right:* The SFR-H α -luminosity relation for four different IGIMF scenarios and relations by Kennicutt et al. (1994, gray shaded area) and the widely used relation $\text{SFR} / M_{\odot} \text{ yr}^{-1} = L_{\text{H}\alpha} / 1.26 \cdot 10^{41} \text{ erg s}^{-1}$ (solid line).

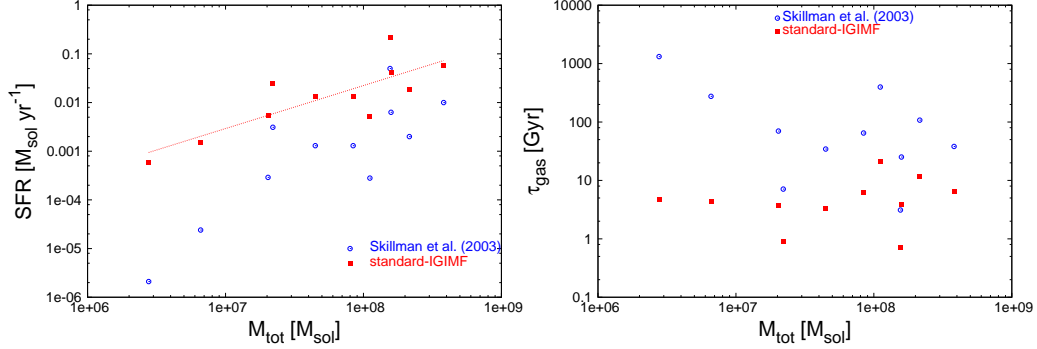


Figure 2. Derived SFRs (*left*) and gas depletion times (*right*) of the Sculptor dIrrs based on the standard IGIMF scenario and on the linear Kennicutt-relation (Fig 1, solid line) (Skillman et al. 2003). Note that the standard-scenario IGIMF implies significantly higher SFRs and a constant gas-depletion time scale for all dwarf galaxies.